Accuracy of Robotic Assisted Femoral Osteochondroplasty for Treatment of FAI

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Disclosure: I DO have a financial relationship with the following commercial interests but are not relevant to this talk:

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Background- CAM Impingement

Reproducible pattern of anterosuperior labral and chondral injury due to abnormal contact between the femoral head/neck junction and the anterior acetabulum during terminal hip flexion.
The Issues

• Impingement surgery has grown tremendously
• Open techniques have rudimentary templates
• Arthroscopic has none
• Both are technically challenging in defining accurate resection and zones of impingement
Can haptic robotics improve accuracy and precision and avoid the technical errors that lead to revision procedures?
Haptic Robotics for FAI

Eliminate Negative Features of FAI Surgery

• 1mm accuracy: eliminates under-, over- and inaccurate resection
• Eliminate surgical learning curve
• Minimize fluoroscopy
• Arthroscopic application
Pre-op Planning

- 3D CT based patient specific
- Can use a pure anatomic plan, kinematic plan or combination
- Define a 3D $\alpha$ angle
- Define resection depth in line with femoral neck
- Calculate resection volume
Material & Methods

- 16 identical sawbones models with cam deformity
  - 3D anatomic plan
  - 8 freehand
  - 8 robotic by creating a 3-D haptic volume defined by plan
- Laser Scanned
  - LPX-600 Laser Scanner
  - 1mm plane scanning pitch
  - 0.9 degree rotary scanning

Ranawat et al., AAOS, 2011
Materials & Methods

Measured:

- Arc of resection
- Start and end point
- Resection depth
- Volume of bone removed
## Results

- Desired arc of res was 117.7° (start at -1.8°, ending at 115.9°)

<table>
<thead>
<tr>
<th></th>
<th>Manual</th>
<th>Robot</th>
<th>Factor</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arc resect error</strong></td>
<td>42.0 ± 8.5°c</td>
<td>1.2 ± 0.7°c</td>
<td>35</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td><strong>Start error</strong></td>
<td>-18.1 ± 5.6°</td>
<td>-1.1 ± 0.9°</td>
<td>16.5</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td><strong>End error</strong></td>
<td>23.9 ± 9.9°c</td>
<td>-0.1 ± 1.0°c</td>
<td>239</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td><strong>Avg. Vol. Error</strong></td>
<td>758.3 ± 477mm³</td>
<td>31.3 ± 221mm³</td>
<td>24.2</td>
<td>p&lt;0.01</td>
</tr>
</tbody>
</table>
Conclusion

• Robotic assistance *significantly* more accurate, less variable than manual.
• Success of FAI surgery depends on accurate, precise boney resection

Future Directions

• Pincer & Combined Deformities
• 3D to 2D Bone Registration
• Portal & Anchor Placement
References


